



ERSC 2P18 Library Assignment & Orientation

Ian Gordon & Nicole Stradiotto



Ian Gordon, Teaching & Learning Librarian



Nicole Stradiotto, Data Services Librarian

ERSC 2P18 - Library Assignment

Agenda

Review the assignment

Library's Earth Sciences Research Guide

Databases – we have lots of them

Citation management zoterobib & Zotero

Geoscience maps, data and resources

Practice / Q&A

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<https://researchguides.library.brocku.ca/ERSC>

Earth Sciences

WELCOME

ARTICLES

BOOKS

GOVERNMENT

GREY LITERATURE

MAPS & DATA

BORROW FROM OTHER LIBRARIES

ADDITIONAL COURSE GUIDES

ERSC 2P18

Need Help?



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find more library help on our
[Research Support](#) page.

Earth Sciences

What is this guide for?

This guide has been designed as a general program guide and is curated by [Brock librarians](#). It features links to most often used resources such as databases for books, peer-reviewed journal articles, theses, dissertations, open educational resources (OEDs), and more. Use the tabs on the left to navigate through the web page.

The [Map, Data & GIS Library](#) located in Mackenzie Chown Complex Rm C306 provides geospatial data, maps, GIS-related resources and friendly assistance.

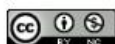
[Brock University Campus Rock Tour](#) - check it out!

ERSC 2P18 Winter 2024, Library Exercise [form](#) (Google Docs), Kapuskasing Uplift [sample](#) (Google Docs) & ppt [slides](#) (PDF).

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ERSC 2P18 - Library Assignment

This assignment will serve to familiarize you with the services available in the James A. Gibson Library to assist you in locating resources relevant to Earth Sciences. Each student must select one Earth Science related topic from the list below. Note resources including a "Kapusasing Uplift" completed example available on the Brock Library [Research Guide for Earth Sciences](#) under the ERSC 2P18 tab.

The report for your library assignment will consist of a one page (yes! just one page), single-sided, single-spaced 'information' sheet on your selected topic and must contain the following (see the sample layout):

- 1) A legible location map (with citation reference) of the feature described;
- 2) A definition/description of the topic/feature chosen, highlighting - what it is, where it is, how old it is in geological terms, relation to geological plates/zones;
- 3) Significance to earth science – why it is important, how does it relate to plate tectonics;
- 4) A citation list of the three most useful references (post 1990, APA works) with URL links, at least one citation must be a peer-reviewed scholarly article;
- 5) A list of the 5-9 most productive database keywords/phrases you searched that describe this feature in the earth sciences literature.

Sample Search Topics

Belcher fold, Cape Smith belt, Fox River belt, Great Lakes tectonic zone, Great Slave Lake shear zone, Killarney magmatic zone, Keweenaw rift, Thompson [Nickle](#) belt, Hearne province, Rae Province, Slave Province, Superior Province, Nain Province, Torngat orogen, Wopmay orogen, Penokean Terrane, Grenville orogen, Snowbird tectonic zone, Cape Smith belt, New Quebec orogen, Thelon orogen, Great Slave Lake shear zone, Queen Maud uplift, Coronation Supergroup, McDonald-Bathurst fault system, Tulemalu Lake fault zone, Baker Lake basin, Kiseynew Domain, La Ronge belt, Flin Flon Belt, Lynn Lake belt, New Quebec orogen, Abloviak shear zone, Komaktorvik shear zone, Foxe fold belt, Hottah terrane, Nahanni belt, Reindeer Zone, Needle Falls shear zone, Thompson Nickel Belt, [Narsajuaq](#) Arc, Sugluk Group, Sask Craton, Grenville Front Tectonic Zone, Central Gneiss Belt, Wawa Gneiss Terrane, Parry Sound Domain, Central Metasedimentary Belt, Britt Domain, Sudbury Igneous Complex, Abitibi Greenstone Belt, Kenoran Orogeny, Mackenzie Dyke Swarm, Grenvillian Orogeny, Birch-Uchi Greenstone Belt, [Avalonia](#) Terrane, Bancroft Terrane, Quesnel Terrane, Cache Creek Terrane, [Stikinia](#) Terrane, Intermontane belt, Alexander Terrane, Wrangellia Terrane, Insular Terrane, Meguma Terrane, Cassiar Terrane, Yukon Tanana group, Mazinaw Terrane, Quesnel Terrane, Gagnon Terrane, Omineca Belt

or a pre-approved Canadian topic of your choice.

Your Name:

Feature Name:

Map significance:

Location Map (must be legible)

Feature significance to Earth Science:

Citation References:

Keywords:

Your Name:

Location Map (must be legible)

Feature Name:

Map significance:

Feature significance to Earth Science:

Citation References:

Keywords:

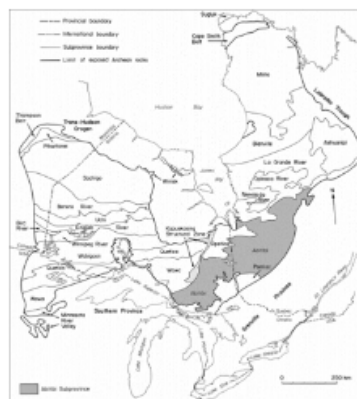
ERSC 2P18 Library Assignment

Ian Gordon, igordon@brocku.ca

Feature Name: Kapuskasing Uplift (KU)

Definition/Description: The KU is a geological Northern Ontario Canadian Shield Superior Province 500 km long that runs from Lake Superior to James Bay, is approximately 3.6 to 2.75 Ga in age, tectonically stable, northeast-trending, fault-bounded structure that divides the Superior Province into eastern and western halves. This uplift with moderate dipping units of 25-35 km in depth, with 60-70 degrees northwest plate dip, with 7-10 km displacement is complete with exposed thrusts, marginal rifting, mafic dyke swarms, and localized high-grade metamorphism.

Map significance: This base geological structure area map (Jackson & Fyon, 1991) best depicts geological provinces together with geographic, political and plate boundaries as well as including a clear delineation of the KU feature as best depicted from recent survey data. This map is clear to follow, identifies and illustrates the proximity of the Abitibi subprovince, regional plate-like structures, and the central Superior Province as the largest geological Province of the Canadian Shield in Ontario. The map's title, scale and author are not noted and like so many geological maps it was pulled and modified from a previous 1986 source. A clean geological map that has been reproduced in several other texts and online images.



Source: Jackson, S. L., & Fyon, J. A. (1991). The Western Abitibi Subprovince in Ontario. In P. C. Thurston et al. (Eds.), *Geology of Ontario Special Volume 4, Part 1*, (pp. 405-482). Toronto: MNDM. (p. 406).

Feature significance to Earth Science: The KU structure was first documented by researchers up to the 1970s through major gravity and aeromagnetic anomaly measurements with related research first published in the 1980s to the present. Tectonic investigations of staged folding of large converging plates together with submarine volcanism, tectonic thickening of sediment-laden metamorphosed structures, and large-scale terminal subduction creating sizable complex crustal-scale shear zones. Significance is twofold 1) a relatively easily accessible geological area that led to further investigations of theoretical deep-earth faulting, intracrustal plate movements, and batholith emplacement studies, and 2) the study of localized metamorphosed alkaline, carbonatic intrusions, greenschist-facies, cataclastic, gold, copper, mineral bearing rock structures along easily identifiable, accessible, commercially viable, and shallow regional shear zones.

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4. Percival, J. A., & West, G. F. 1994. The Kapuskasing Uplift: A geological and geophysical synthesis. *Canadian Journal of Earth Sciences*, 31, 1256-1286. doi: 10.1139/e94-110
5. Perry, H. K. C., Marechal, J. C., & Jaupart, C. (2006). Variations of strength and localized deformation in cratons: The 1.9 Ga Kapuskasing uplift, Superior Province, Canada. *Earth and Planetary Science Letters*, 249, 216-228. doi:10.1016/j.epsl.2006.07.013

Keywords: Canadian Shield, Kapuskasing Uplift, Superior Province, Archean, plate boundaries, faulting, shear zones.

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or a **pre-approved** Canadian topic of your choice.

Selected Features

Cape Smith belt, Fox River belt, Great Lakes tectonic zone, Great Slave Lake shear zone, Killarney magmatic zone, Keweenawan rift, Thompson Nickle belt, Hearne province, Rae Province, Slave Province, Superior Province, Nain Province, Torngat orogen, Wopmay orogen, Penokean Terrane, Grenville orogen, Snowbird tectonic zone, Cape Smith belt, New Quebec orogen, Thelon orogen, Great Slave Lake shear zone, Queen Maud uplift, Coronation Supergroup, McDonald-Bathurst fault system, Tulemalu Lake fault zone, Baker Lake basin, Kisseynew Domain, La Ronge belt, Flin Flon Belt, Lynn Lake belt, New Quebec orogen, Abloviak shear zone, Komaktorvik shear zone, Foxe fold belt, Hottah terrane, Nahanni belt, Reindeer Zone, Needle Falls shear zone, Thompson Nickel Belt, Narsajuaq Arc, Sugluk Group, Sask Craton, Grenville Front Tectonic Zone, Central Gneiss Belt, Wawa Gneiss Terrane, Parry Sound Domain, Central Metasedimentary Belt, Britt Domain, Sudbury Igneous Complex, Abitibi Greenstone Belt, Kenoran Orogeny, Mackenzie Dyke Swarm, Grenvillian Orogeny, Birch-Uchi Greenstone Belt, Avalonia Terrane, Bancroft Terrane, Quesnel Terrane, Cache Creek Terrane, Stikinia Terrane, Intermontane belt, Alexander Terrane, Wrangellia Terrane, Insular Terrane, Meguma Terrane, Cassiar Terrane, Yukon Tanana group, Mazinaw Terrane, Quesnel Terrane, Gagnon Terrane, Omineca Belt

ERSC 2P18 Library Assignment

Your Name / Email Address:


Feature Name:

Definition/Description:

Map significance:

Feature significance to Earth Science:

Location Map



Source:

Citation References (indicate which citations are peer-reviewed scholarly articles):

- 1.
- 2.
- 3.
- 4.
- 5.

Keywords:

Feature Name

Location map of your choosing, full citation below map

Definition/Description

Comment on the significance of this map

Why is this feature significance to Earth Science / plate tectonics?

5 Citation References, 1990+, highlight which two are peer reviewed articles

5-9 keywords

On one single page!

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ERSC 2P18

Library Seminar Resources for ERSC 2P18 Assignment

Information and Resources provided as part of a ERSC 2P18 Winter 2024 seminar.

Library Seminar [slides](#) (Jan 23, 2024, PDF)

[ERSC 2P18 Library Assignment Form](#) (Google Docs)

[ERSC 2P18 Completed Library Assignment Kapuskasing Uplift](#) (Google Docs)

[What's Peer Review?](#) (YouTube, Brock Library, 2021, 1:33)

[How to Reference Geospatial Data, Maps, Atlases, Air photos](#) (PDF, Brock MDG Library)

- [Brock Library Article Databases](#)

There are several databases that index and abstract the world's research. Those used for this assignment may include Omni, Google Scholar, and GeoRef (a must use!). Databases that scan full-text resources of articles include GeoScienceWorld, BASE, CORE, and Scholars Portal E-Journals. Your task is to find at least five post 1990 resources with two being peer-reviewed scholarly articles.

- **GeoRef** [↗](#)

- International coverage of earth sciences, geology and related geosciences literature.
- Find journal articles, books and book chapters, conference papers, government publications, geological surveys, theses, dissertations, reports, and maps.
- Includes: The U.S. Geological Survey library in Reston, VA (1967 to date), the Bibliography of North American Geology (1785-1970), the Bibliography and Index of Geology Exclusive of North America (1933-1968), Bibliography of Fossil Vertebrates (1973-1991), and Geophysical Abstracts (1951-1971) and select records from Geoline (1985 -), PASCAL (1982 -), and several state and national geologic surveys.

- **Permitted Uses**

[more info...](#)

- **GeoScienceWorld** [↗](#)

- A comprehensive resource for research and communications in the geosciences linked to, and inter-operable with GeoRef.
- All journals have a minimum of one back year, but most start in the year 2000, there is also an archive of pre-2000 articles from the Millennium Collection.

- **Permitted Uses**

- **Web of Science Core Collection** [↗](#)

- Scholarly resources across all disciplines
- Access to Cited Reference searching.
- Includes Proquest Dissertations and Theses Citation Index.

- **Permitted Uses**

[more info...](#)

- **GeologyOntario**

Search using this database by keyword and phrases to find alternate resources to learn more about the significance of your topic, find a map or develop a list of additional keywords. This database does not include journal articles, but does include essential references on Ontario geology published by government researchers. Your task is to find a Geological Survey of Ontario Report or a series of maps and data that supplements your feature. Again, only Ontario.

- **GEOSCAN (Canada GSC)**

Publications of the Geological Survey of Canada and the Canada Centre for Remote Sensing Canada Topographic Maps. GEOSCAN links to external publications including journal articles, open source publications, and reports authored by ESS scientists and specialists.

Books and resources of supplementary interest:

- [List of Canadian, provincial, and regional geology surveys, agencies and departments](#) (Manitoba, Economic Development, Investment, Trade and Natural Resources)
- [Plate Tectonics: Continental Drift and Mountain Building](#) (course textbook, 1st edition, 2011)
- [Plate Tectonics: Continental Drift and Mountain Building](#) (course textbook, 2nd edition, 2020, on order)
- [Geology of Ontario](#) (2 volumes, Brock Library print copy, 1991-92, OGS)
- [Geology of Ontario](#) (GeologyOntario, PDF, [downloadable volume 1 copy](#), 1991-92, OGS)
- [Geology of Ontario](#) (GeologyOntario, PDF, [downloadable volume 2 copy](#), 1991-92, OGS)
- [Fifty years of the Wilson Cycle Concept in Plate Tectonics](#) (2019, Geological Society)
 - [Introductory Overview Essay](#) (PDF)
- [Geological Evolution of North America](#) (1979, 3rd ed)
- [Continents and Supercontinents](#) (2004)
- [Exposed Cross-sections of the Continental Crust](#) (1990)
- [Plate Tectonics and Crustal Evolution](#) (note different print and older ebook editions, Condie)
- [Decade of North American Geology](#) (1986, 36 volumes, classic description of NA geology, including tectonic plates, ask for help finding the volume and corresponding map sets)
- [Regional Stratigraphy of North America](#) (1987)
- [Large Igneous Provinces](#) (2014)
- [Plate Boundaries and Natural Hazards](#) (2016)
- [This Dynamic Earth: The Story of Plate Tectonics](#) (USGS)
- [Plate Tectonics and Great Earthquakes: 50 Years of Earth-Shaking Events](#) (2019)
- [Plate Tectonics Continental Drift and Mountain Building](#) (2011)
- [Principles of Rock Deformation and Tectonics](#) (2021, based on lab, teaching and field experiences)
- [The Tectonic Plates are Moving](#) (2018, gotta read chapter titled Plate Tectonics by Jerks)
- [Geology of the Canadian Shield in Ontario: An Update](#) (2007, GSC Open File 5511,PDF)
- [The Geology of North America: An Overview](#) (1989, a classic NA resource similar to the Geology of Ontario, GSA)
- [Plate Tectonic Evolution from 1 Billion Years ago to the Present](#) (2021, EarthByte, YouTube, 40 seconds)
- [Principles of Rock Deformation and Tectonics](#) (2021)
- [Regional Geology and Tectonics: Principles of Geologic Analysis](#) (2020)
- [Tuzo :The Unlikely Revolutionary of Plate Tectonics](#) (2022)



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Geology Related Links

[Provincial & Territorial Governments of Canada](#)

[Earth Sciences Resources Catalogue of Publications](#)

[Natural Resources Canada: Earth Sciences](#)

Canada - Federal

[Department of Finance Canada](#)

[Innovation, Science and Economic Development Canada](#)

[Canadian Primary Metals Industry](#)

[Natural Resources Canada](#)

[Minerals and Metals Facts](#)

[Mining Taxation in Canada](#)

[Minerals and Metals Markets](#)

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[Québec](#)

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Associations of Canada

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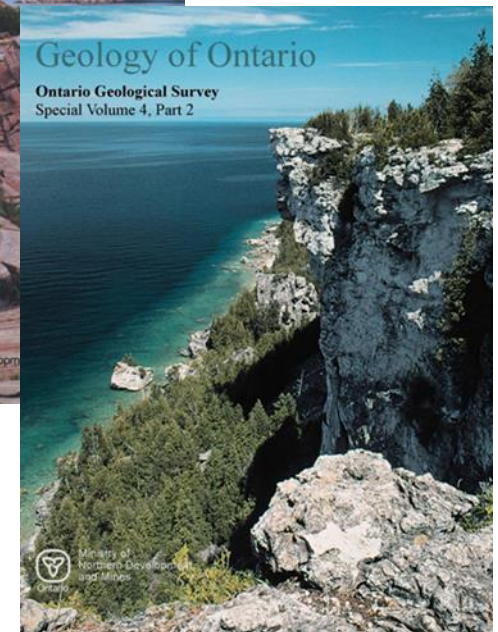
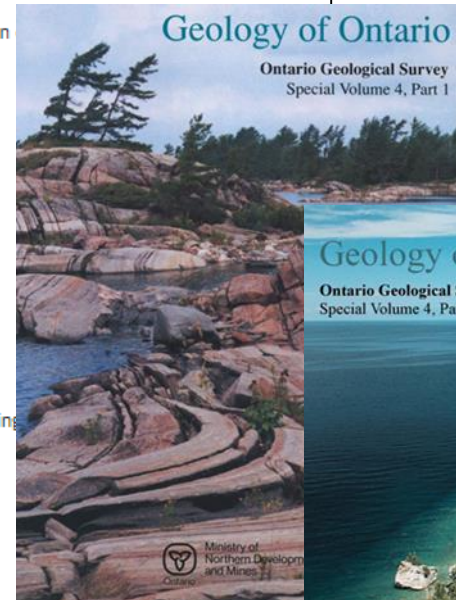
[Geological Association of Canada](#)

[Mining Association of Canada](#)

[Prospectors & Developers Association of Canada \(PDAC\)](#)

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- **Plate Tectonics: Continental Drift and Mountain Building** (course textbook, 2nd edition, 2020, on
- **Geology of Ontario** (2 volumes, Brock Library print copy, 1991-92, OGS)
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- **Fifty years of the Wilson Cycle Concept in Plate Tectonics** (2019, Geological Society)
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Ontario Geological Survey

Special Volume 4

Part 1

Geology of Ontario

Edited by

P.C. Thurston, H.R. Williams,
R.H. Sutcliffe and G.M. Stott

1991



Ministry of
Northern Development
and Mines



Milne, V. G., Thurston, P. C., Williams, H. R., Sutcliffe, R. H., & Stott, G. M. (1991). Geology of Ontario: 1. Ministry of Northern Development and Mines, Ontario.

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Ctrl F “Kapuskasing” to find citations

kapuskasing

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complexes. The deformation zone, which is several kilometres wide, defines the boundary between the Wawa and Quetico subprovinces and displays tectonic indicators showing a dextral horizontal component of movement (Williams 1989).

The major alkaline event along the TSTZ occurred from 1.0 to 1.2 Ga. In addition, Sage (1983) identified lamprophyre dikes dated at approximately 300 Ma on the Slate Islands by the K-Ar method, and Platt and Mitchell (1982) reported 1653±122 million-year-old lamprophyres dated by the Rb-Sr method in the same region. Work by Heaman and Krogh (1986) indicate that at least some of the lamprophyre dikes in this area interpreted to be of 1600 million year age are younger and have been dated at 1130 Ma by the U-Pb method; therefore, they are similar in age to the main alkaline event in the region.

Kapuskasing Structural Zone

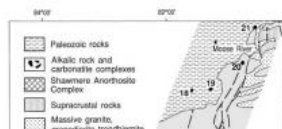
The Kapuskasing Structural Zone (KSZ) extends from the east shore of Lake Superior northeast to James Bay (Figure 18.4). The KSZ is poorly defined along the east shore of Lake Superior but becomes better defined towards James Bay. The KSZ crosscuts an east-trending fabric within Archean rocks of the Superior Province and is subparallel to the TSTZ (see Figure 18.2).

The KSZ is characterized by a northeast-striking linear aeromagnetic pattern (400 to 600 gammas above regional background) and positive gravity highs (up to 20 mgal (Innis 1960; ODM-GSC 1970; GSC 1984). Numerous alkaline and carbonatite intrusions occur along this structure (see Figure 18.4).

The KSZ has been interpreted as an upwarp of the Conrad Discontinuity (Wilson and Brisbin 1965; Bennett et al. 1967; Thurston et al. 1977), a product of collision of the Churchill and Superior cratons in Paleoproterozoic time (Gibb 1978) and as a deep transcurrent shear (Watson 1980). More recently, Percival and Card (1983) have proposed that the KSZ is an east-verging thrust fault which has exposed at oblique section through 20 km of uplifted Archean crust. Granulite-facies rocks of the KSZ are juxtaposed against greenschist-facies rocks of the Abitibi Subprovince along the Ivanhoe Lake cataclastic zone. The KSZ is characterized by a high-grade gneiss terrain and grades westward into central gneiss terrain and then into low-grade terrain of east-west-striking linear belts composed of supracrustal rocks.

In addition to the major fault which forms the east boundary of the KSZ, 3 major northeast-striking faults dip 60° to 70° northwest and are present within the uplift (Percival and McGrath 1986). These internal faults are west-side-down with displacement of 7 to 10 km and result from a late tensional event that followed the compressional uplift (Percival and McGrath 1986; Percival 1987).

Northey and West (1986) have interpreted seismic refraction data to indicate a crustal thickness of 48 km below the KSZ, which thins slightly to the west and the east. The



Chapter 12

Wawa Subprovince

H.R. Williams, G.M. Stott, K.B. Heather, T.L. Muir and R.P. Sage

Precambrian Geology Section, Ontario Geological Survey

Abstract

In the Wawa Subprovince, at least 3 stages of supracrustal development are postulated: 2.89, 2.75 and 2.70 Ga. Tectonic assemblages of komatiite to tholeiitic basalt, gabbro, and diorite, and by sporadic centres of submarine to subaerial diorite to felsic volcanic rocks. Volcanic sequences are commonly overlain by, or into, aprons of sediment. Some assemblages developed one upon another, others came tectonically juxtaposed to form aggregates, called greenstone belts. Uplifts are uncommon; most assemblages were juxtaposed along shallow-dip faults subjected to recumbent folding.

Between these greenstone belts, that form but 20 to 36% of the subprovince consist of massive, foliated and gneissic tonalite-granodiorite which are cut by rhyolite and granite. Most granitoids were emplaced during or after production of the greenstone belts, which the granitoids are spatially associated. Granitoid emplacement was in foliation and controlled the shapes and sizes of the characteristically steeply dipping greenstone belts.

The Wawa Subprovince was amalgamated with the Quetico accretionary complex by plate convergence and transpressive interaction during the late Proterozoic. The subprovince is the site of iron and gold deposits.

INTRODUCTION

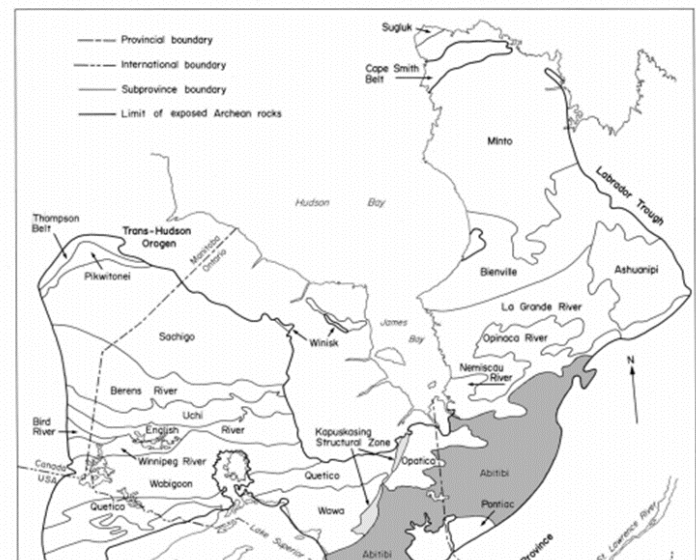
The Wawa Subprovince is an aggregation of Archean greenstone belts and granitoid plutons (Figure 12.1). The northern boundary (Figure 12.2) lies in tectonic contact against structurally overlying metasedimentary rocks of the Quetico Subprovince (see Williams, this volume). The southern boundary of the Wawa Subprovince is marked by the Montreal River fault in the east, and is hidden beneath Lake Superior and by unconformable Proterozoic supracrustal rocks of the Animikie Basin in the west.

The Great Lakes Tectonic Zone separates the Wawa Subprovince from the Marquette greenstone belt and the Minnesota River Valley gneiss terrane to the south (Sims et al. 1980). The subprovince extends from the Kapuskasing Structural Zone in the east where the Wawa Subprovince is interpreted by Percival and Card (1985) to be transitional into the Chapleau block and Val Rita block, forming the southern and central parts of the Kapuskasing Structural Zone. The western end of the Wawa Subprovince abuts against the Proterozoic Trans-Hudson Orogen, which trends southward through Manitoba; both are hidden beneath Phanerozoic rocks.

The Wawa Subprovince is characterized by a high-grade gneiss terrain and grades westward into central gneiss terrain and then into low-grade terrain of east-west-striking linear belts composed of supracrustal rocks. The Wawa Subprovince is characterized by a high-grade gneiss terrain and grades westward into central gneiss terrain and then into low-grade terrain of east-west-striking linear belts composed of supracrustal rocks. The Wawa Subprovince is characterized by a high-grade gneiss terrain and grades westward into central gneiss terrain and then into low-grade terrain of east-west-striking linear belts composed of supracrustal rocks.

only within the N. Turek, Keller and Muir (1989a) and Stott (1986). Accretion sections that cover greenstone belts or contain the Dayville Homophyre and 3 major plutonic are lithic; and the Sheb Figure 12.2). For supracrustal and p deposits are follow of tectonic events, view and discussion tectonic sequence of ment of the Wawa ing Quetico and A

There is a cor logical informati province and this scriptions. All A



Jackson, S. L. & Fyon, J. A. (1991). The Western Abitibi Subprovince in Ontario. In P. C. Thurston et. al. (Eds.), *Geology of Ontario Special Volume 4, Part 1* (pp. 405-482). Toronto: Ministry of Northern Development and Mines.

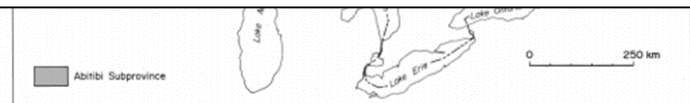
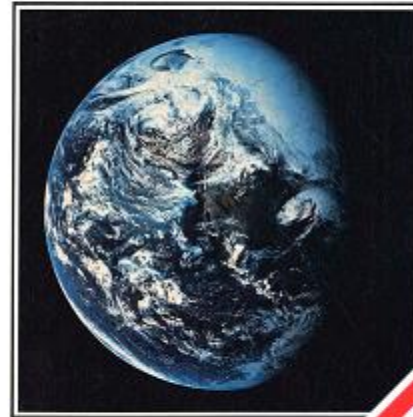


Figure 11.1. Location of the Abitibi Subprovince in the central Superior Province (modified from Card and Ciesielski 1986).

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- [List of Canadian, provincial, and regional geology surveys, agencies and departments](#) (Manitoba, Economic Development, Investment, Trade and Natural Resources)
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PDF

Lucas, S. B., & St-Onge, M. R. (1998). Geology of the Precambrian Superior and Grenville Provinces and Precambrian fossils in North America. Geological Survey of Canada. DNAG v. C-1. GSA, GSC.

Geology of the Gowganda Lake-Miller Lake Silver Area

District of Timiskaming

By
W.H. McIlwaine

1978

Ministry of
Natural
ResourcesHon. Frank S. Miller
Minister
Dr. J.K. Reynolds
Deputy Minister

STRUCTURAL GEOLOGY

Folds

Evidence of large-scale folding is present in the Early Precambrian metavolcanics. In these rocks the foliation trend swings from eastward in Van Hise, Haultain, and northern Nicol Townships to a southward strike in central Nicol Township; dips are steep mainly to the north and east. Top determinations from pillows in two localities suggest these inliers are disconnected segments of an antiform which existed prior to Middle Proterozoic.

Undulations in the Nipissing Diabase are the result of post-emplacement folding.

The Huronian rocks have been gently folded to the south in the Maple Mountain area as a result of a greater distance from the influence of the Gowganda Lake-Miller Lake area.

Faults in the area trend in four main directions: northwest, northeast, and east. Criteria include shearing and brecciation, altered mineralogical contacts, and repetitions of formations.

ECONOMIC GEOLOGY

Serpentine

Small serpentinized dunite bodies occur in the Firth Lake-Serpentine Lake area of Van Hise Township. Narrow stringers of asbestiform serpentine occur locally in outcrops; diamond drilling by Texmont Mines Limited in 1966 indicated similar stringers of serpentine at depth.

Silver-Cobalt and Associated Mineralization

Silver, with associated nickel-cobalt-iron arsenides, has been the only product of the Gowganda Lake-Miller Lake area; there has been almost continuous production since 1908 when silver was first produced for the camp are shown in Table 11. It is the dollar value on this production due to the Gowganda Lake-Miller Lake area.

Information pertaining to the description and general geology of the Gowganda Lake-Miller Lake area is included in those by E.W. Todd (1926), E.S. Moore (1955). More recent studies have been published by Hester (1967). The most comprehensive study is contained in a special volume of The Canadian Journal of Earth Sciences, entitled "Arsenide Deposits of the Cobalt-Gowganda Lake-Miller Lake area."

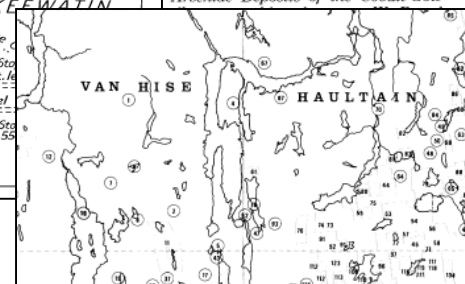
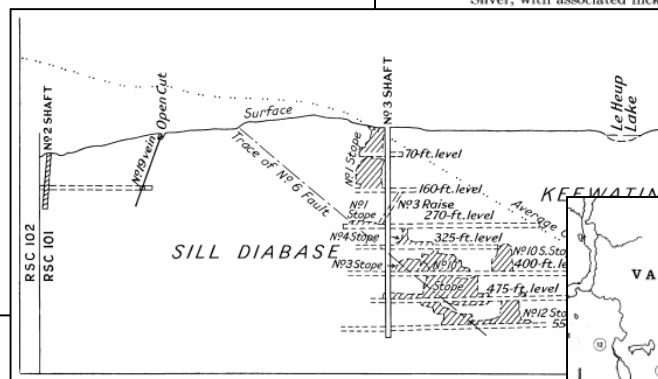
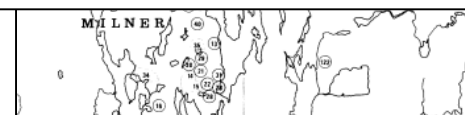


TABLE 9 MODAL ANALYSES OF OLIVINE DIABASE DIKE.
(Values in percent).

Specimen	W-6-10	W-9-10
Plagioclase (% An)	59.1 54	
Pyroxene	17.1	
Olivine	18.3	11.7
Magnetite	3.7	7.2
Biotite-Chlorite	1.8	4.6
Totals	100.0	100.0

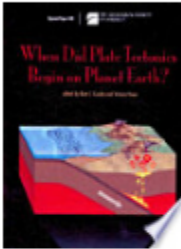
McIlwaine, W. H. (1978). Geology of the Gowganda Lake-Miller Lake silver area : District of Timiskaming. Ontario Ministry of Natural Resources.



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Condie, K. C., & Pease, V. (Eds.). (2008). *When did plate tectonics begin on planet Earth?* Boulder: CO, Geological Society of America.



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When Did Plate Tectonics Begin on Planet Earth? - Page 214

Kent C. Condie, Victoria Pease · 2008

FOUND INSIDE – PAGE 214

... KU—Kapuskasing uplift; NKF—North Kenyon fault; OB—Oplaca basin; P—flat-lying Proterozoic cover; PB—Pontiac Province and that argue for establishment of modern-style plate tectonics on Earth by the end of the Archean.

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Pease et al.

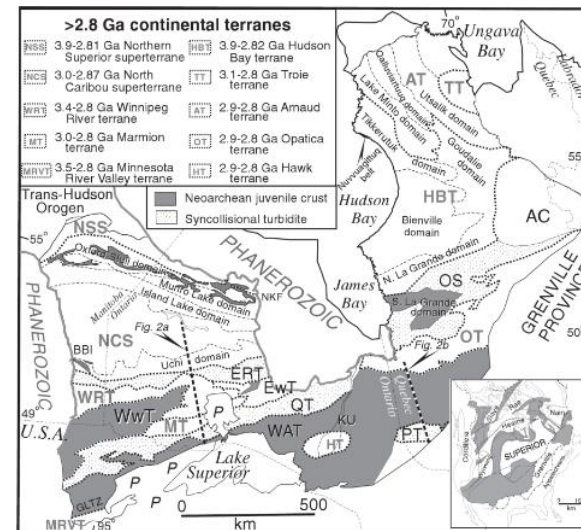


Figure 7. Tectonostratigraphic terrane map of the Superior Province showing distribution of Eo- to Mesoproterozoic continental fragments, Neoproterozoic juvenile crust, and synorogenic turbidite basins. Additional abbreviations not shown in legend: AC—Ashuanipi complex; BBI—Bidou-Black Island terrane; ERB—English River basin; EwT—eastern Wabigoon terrane; GLTZ—Great Lakes tectonic zone; KU—Kapuskasing uplift; NKF—North Kenyon fault; OB—Oplaca basin; P—flat-lying Proterozoic cover; PB—Pontiac basin; QB—Quelico basin; WAT—Wawa-Abitibi terrane; WwT—western Wabigoon terrane.



kapuskasing and (structure or uplift or terrane)



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1. THE KAPUSKASING UPLIFT

The Kapuskasing uplift occurs within the Superior Province, an Archean terrane of diverse lithological character. The southern part of the province consists of east-trending, alternating granite-greenstone and metasedimentary gneiss belts, whereas the north appears to be uniformly high-grade gneiss (Card and Ciesielski, 1986; Fig. 1). Seismic refraction studies over granite-greenstone terranes detect a mid-crustal discontinuity with an increase of P-wave velocity (V_p) on the order of 0.3 km.sec⁻¹ (Berry and Fuchs, 1973; Green et al., 1979; Hall and Brisbin, 1982).

In the south-central part of the Province, the Kapuskasing uplift exposes rocks that show continuous transitions from greenstones, to amphibolite-facies gneisses, into granulites (Fig. 1). The lithological transition coincides with an increase in metamorphic grade and pressure, from 200-300 MPa (2-3 kb) greenschists, through amphibolites, to 700-900 MPa (7-9 kb) granulites (Percival, 1983; Percival and McGrath, 1986). This transect has been interpreted as an uplifted, oblique cross-section through the upper two-thirds of the crust (Percival and Card, 1983; 1985), based on the criteria of Fountain and Salisbury (1981). The amphibolite-granulite boundary zone corresponds to an increase in average density (Percival, 1986) and seismic velocity (Percival and Salisbury, 1986) that makes it analogous to that observed at depth elsewhere. Anomalous high-velocity zones were recorded over the Kapuskasing structural zone in recent seismic reflection (Cook, 1985) and refraction (Northey and West, 1986) experiments.

The region affected by the Kapuskasing uplift can be divided into four distinct lithological domains, from west to east (1) the Michipicoten greenstone belt; (2) the Wawa gneiss terrane; (3) the Kapuskasing structural zone; and (4) the Abitibi greenstone belt. Only domains 2 and 3 are relevant to this discussion; more background information is available in Percival and Card (1985).

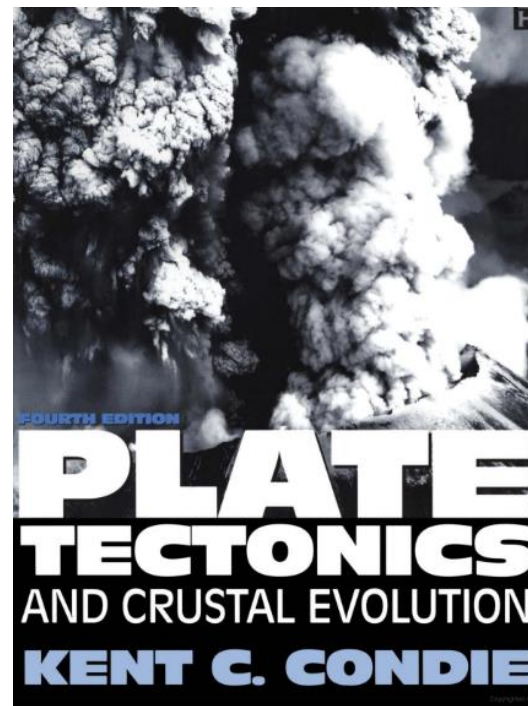
The Wawa gneiss terrane comprises predominantly amphibolite facies biotite ± hornblende tonalitic rocks, with variable amounts of clinopyroxene-bearing mafic xenoliths, intruded by later granodiorite and granite. Several large-scale domal structures have been identified

in the Kapuskasing uplift
ss terrane; (3) the

models of evolution for the
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tonic settings of granulite

Condie, K. C. (2007). Plate tectonics and crustal evolution. London: Butterworth Heinemann.

vince, Canada: A view





GEOLOGICAL SURVEY OF CANADA

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Results of helicopter electromagnetic surveys along the **Kapuskasing** transect, District of Cochrane, Ontario

G.J. Palacky

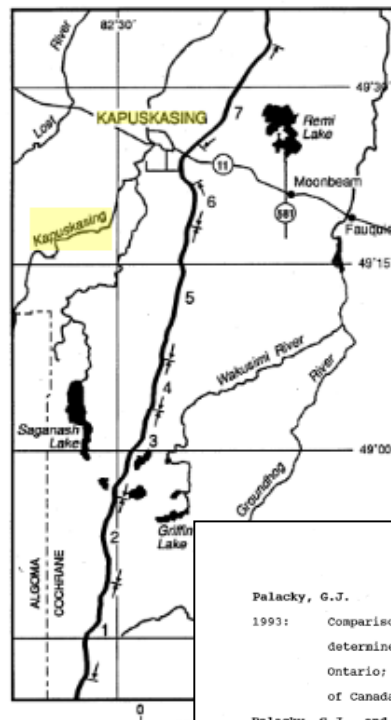
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ABSTRACT

An helicopter electromagnetic and magnetic survey was carried out in 1987 by a contractor, Aerodat Limited of Mississauga, Ontario, along a transect north and south of **Kapuskasing**, Ontario. The survey was a contribution to the Canada-Ontario 1985 Mineral Development Subsidary Agreement under the Economic and Regional Development Agreement and it was funded by the Geological Survey of Canada. The purpose of the survey was to provide geophysical data in support of a Quaternary mapping program. Subsequent to the survey, experiments with various data processing techniques were carried out to determine whether overburden conductivity and thickness can be reliably determined from the electromagnetic data. This **Open File** report contains copies of 7 photomosaics with the layout of the survey and 16 sets of stacked profiles which contain the measured data and calculated overburden conductivity and thickness. Two routines were used in the calculations: least squares inversion based on singular value decomposition (SVD) and centroid depth algorithm (2*).

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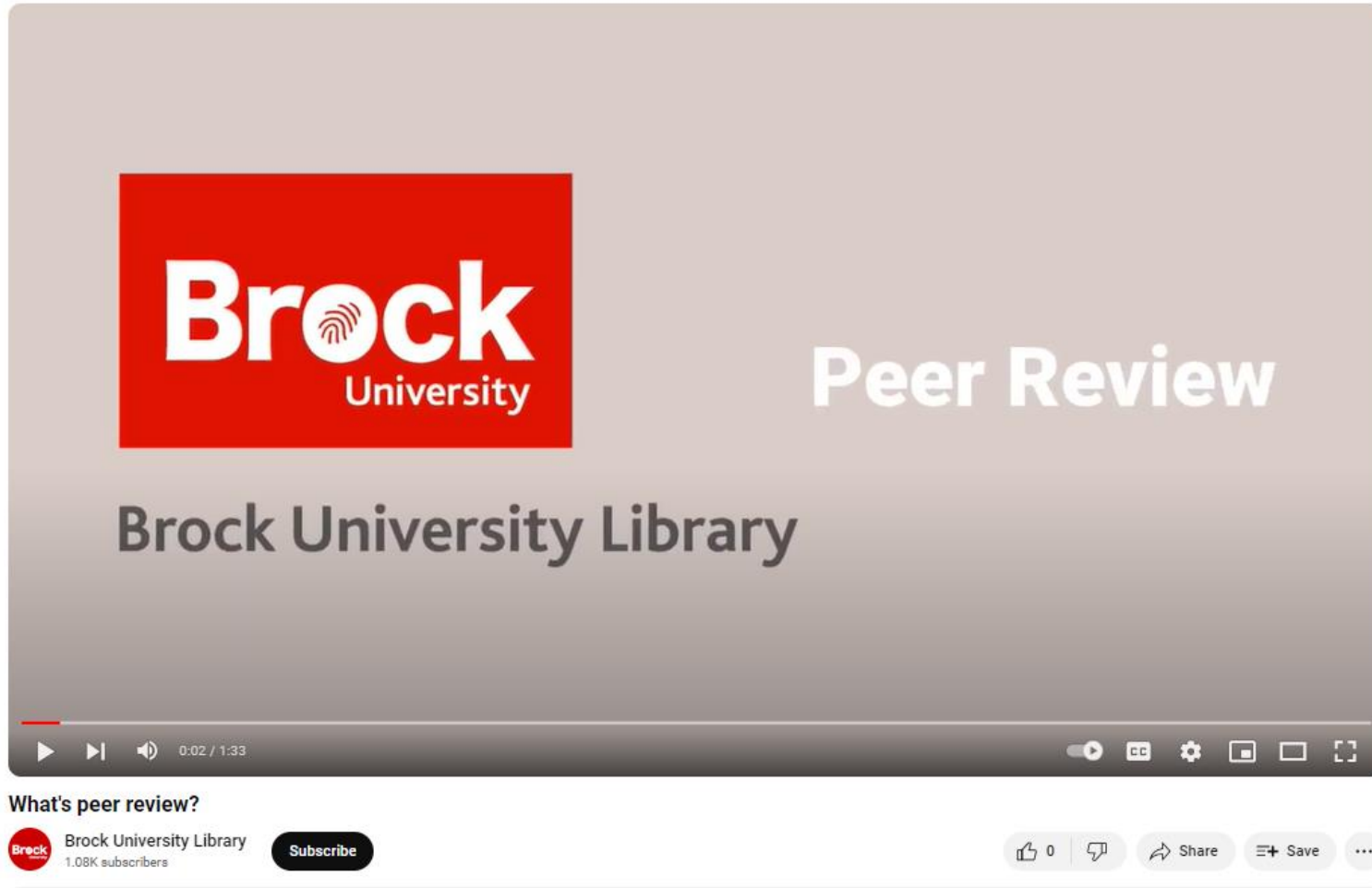
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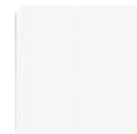


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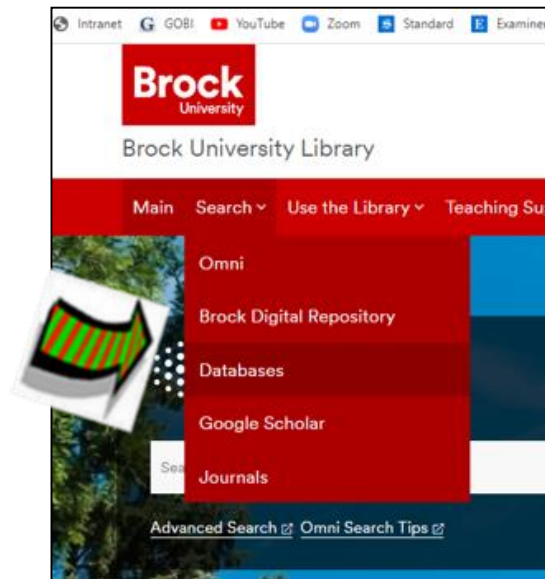
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Archean crust as revealed in the Kapuskasing uplift, Superior province, Canada

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ABSTRACT

In the central Superior province of the Canadian Shield, a 120-km-wide transition from the low-grade Michipicoten greenstone belt to the high-grade Kapuskasing structural zone represents an oblique section through some 20 km of Archean crust, uplifted along a northwest-dipping thrust fault. The restored vertical section through the upper and middle crust consists of three megalayers with undulating boundaries: (1) 0 to < 10 km, a metavolcanic-metasedimentary succession ("greenstone belts") with discordant plutons; (2) < 10 to ~20 km, tabular batholiths of gneissic and xenolithic tonalite and granodiorite; and (3) from 20 to >25 km, a high-grade heterogeneous gneissic assemblage, in part older than the upper supracrustal succession.

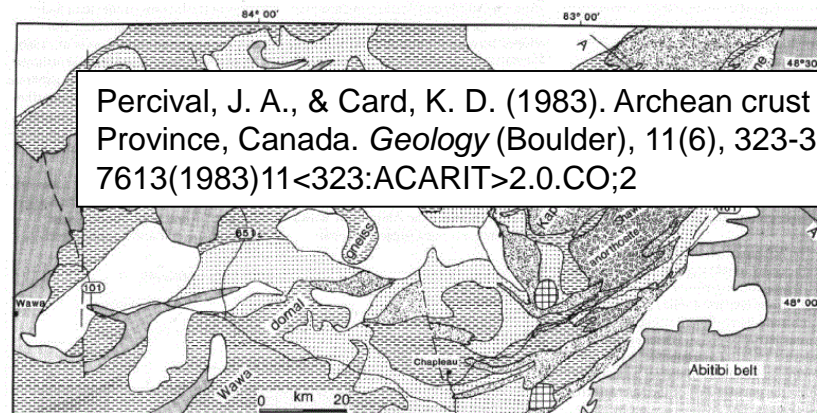
INTRODUCTION

Accurate models of Precambrian crustal evolution require both depth and time dimensions. Zircon geochronology can provide resolution of a few million years in rocks 2,700 m.y. old. Structural relief generally provides the only direct evidence of

variation in the vertical dimension, although gravity and seismic data give valuable information on large-scale crustal structure. Several regions with large-scale, gradational metamorphic zonation and compositional variation have been interpreted as oblique cross sections through

the continental crust (Fountain and Salisbury, 1981). The central Superior province of the Canadian Shield (Fig. 1) is examined in this context.

The Superior province is an Archean terrane composed of east-west-trending belts of alternate volcanic-rich and sediment-rich character, termed subprovinces (Fig. 1). The continuity of the east-west belts is interrupted by a northeast-trending zone of high-grade metamorphic rocks, the Kapuskasing structural zone (Thurston et al., 1977). The Kapuskasing structure is fault-bounded on the southeast, but the western contact is complex and gradational over 120 km to low-grade rocks of the Michipicoten belt near Lake Superior (Fig. 1).



- Proterozoic**
- alkalic rock-carbonatite complex
- Archean**
- massive to foliated granite to tonalite
 - gneissic tonalite-granodiorite
 - xenolithic tonalite gneiss
 - metavolcanic, minor metasedimentary rocks
 - anorthositic rocks
 - paragneiss, mafic gneiss
 - fault



Figure 1. Generalized geologic map showing major lithologic features in transition from low-grade rocks of Michipicoten belt to high-grade gneiss in Kapuskasing zone. ILCZ = Ivanhoe Lake cataclastic zone.

Structural correlation within the Kapuskasing uplift¹

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Comparison of progressive deformation and metamorphic history within and between the tectonic domains of the Kapuskasing uplift indicates significant variation in age and style of deformation across this large segment of the central Superior Province; multiple stages of tonalite and granitoid intrusion, melt generation, polyphase diachronous deformation, and likely rapid deep burial of supracrustal rocks collectively produced the complex character of this example of Archean mid to deep crust. At least four Archean deformation phases are recognized, although not all are of regional extent. Dated structural chronology suggests that the locus of the earliest recorded deformations migrated to deeper crustal levels with time.

Pre-2680 Ma deformation (local D_1 – D_2) within high-level supracrustal belt. The apparent earliest deformational fall Kapuskasing structural zone occurred between 2660 and 2640 Ma (~2667 to ~2629 Ma) are present at mid-crustal and deep crustal levels. The deformation is characterized by large-scale folding and subhorizontal ductile shear that separated a passive upper crust from continued ductile shear.

Subsequent uplift of the high-grade rocks was accomplished around 1.9 Ga, although continued movement of which much of the uplift must have occurred, exhibits some observed structures are brittle to brittle–ductile and steeply dipping shear zones is a characteristic feature of the fault zone throughout its length, and both dextral and sinistral offset are locally present. Clear ground evidence for major transcurrent or thrust displacements, however, has not been recognized.

Une comparaison, de la déformation progressive et de l'histoire métamorphique des domaines ou interdomaines tectoniques du soulèvement de Kapuskasing, révèle que les âges et les styles des déformations varient considérablement au travers ce large segment de la province du lac Supérieur centrale; les nombreux événements intrusifs de tonalite et de granitoïde, la génération de magmas, la déformation polyphasée diachrone, et l'enfouissement vraisemblablement rapide des roches supracrustales, ont tous contribué au développement complexe de cet exemple de croûte archéenne à des niveaux médian à profond. Au moins quatre phases de déformation sont reconnues, quoiqu'elles ne soient pas toutes d'étendue régionale. La datation des événements structuraux suggère que le foyer des premières déformations enregistrées se déplaçait dans le temps vers les niveaux crustaux plus profonds. La déformation antérieure à 2680 Ma (D_1 – D_2 locale), dans les hauts niveaux de la tonalite, est mise en corrélation avec la déformation de la zone supracrustale de Michipicoten. Les fabriques de déformation, apparemment les plus anciennes, qui sont observées dans le terrane à granulites de la Zone structurale de Kapuskasing, à des niveaux crustaux plus profonds, ont été produites entre 2660 et 2640 Ma. La troisième et la quatrième phase de déformation archéenne (~2667 à ~2629 Ma) apparaissent au niveau de la croûte médiane et à plus grande profondeur, et elles ont affecté les conglomérats postérieurs à 2667 Ma; le résultat est la création de zones de plissements à grande échelle et de zones de cisaillement ductile, subhorizontales, qui représentent possiblement une zone de transition majeure, séparant la croûte supérieure passive d'avec les niveaux plus profonds qui étaient assujettis à une déformation ductile continue.

Le soulèvement subséquent des roches de degré de métamorphisme élevé s'est produit par étapes, amorcé avant 2,45 Ga, il a connu sa phase culminante il y a d'environ 1,9 Ga, quoique le mouvement ait été entretenu jusqu'à une époque aussi tardive que 1,4 Ga. La zone de failles du lac Ivanhoe, le long de laquelle le soulèvement fut très actif, présente certains indices de fabrique ductile reliée à un charriage profond, cependant la majorité des structures observées sont de type fragile à fragile–ductile, et elles sont fortement inclinées. L'existence d'une grande zone de cataclase pénétrante et de zones de cisaillement fragile–ductile est la particularité qui caractérise la zone de failles sur toute sa longueur, et localement des décrochements dextre et senestre sont présents. Il n'existe pas sur le terrain d'indices suffisamment clairs pour permettre la reconnaissance de déplacements dus à des charriages ou à des failles coulissantes.

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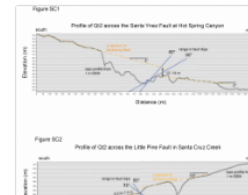
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A FIELD GUIDE TO THE KAPUSKASING UPLIFT, A CROSS SECTION THROUGH THE ARCHEAN SUPERIOR PROVINCE¹

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588 Booth Street
Ottawa, Ontario K1A 0E4

ABSTRACT. The Kapuskasing uplift provides a window on the deep crust of the Superior Province. Evidence in support of an exposed oblique crustal cross section includes: a systematic easterly increase in metamorphic grade from 3 kbar greenstones at Wawa to 8 kbar Kapuskasing granulites; structural and paleomagnetic data on gneisses and dykes indicating 10-15° of east-side-up block rotation; seismic refraction and reflection data tracing the high-velocity Kapuskasing zone from surface down dip at 15°W to about 20 km; and progressively slower cooling rates with paleodepth. The composite cross-section derived from the oblique exposure comprises an upper, 2-3 kbar greenstone-granite megalayer (2.89-2.67 Ga), an intermediate, 5-6 kbar tonalite gneiss megalayer (2.72-2.67 Ga) and a lower, 7-9 kbar, heterogeneous granulite gneiss megalayer (2.76-2.60 Ga). Regional cooling and uplift preceded thrust uplift along the Ivanhoe Lake fault 2.2-1.95 Ga ago. Steep normal faults transecting the uplift possibly reflect topographic collapse and are cut by 1.88 Ga carbonatites. Regional NW-SE shortening of about 70 km during the 2.2-1.88 Ga Kapuskasing event was accommodated above a mid-crustal decollement by 15 km of brittle uplift of granulites along a 15°-dipping fault and below it by 10-15 km of ductile thickening of the present lower crust over a 200-km-wide zone.

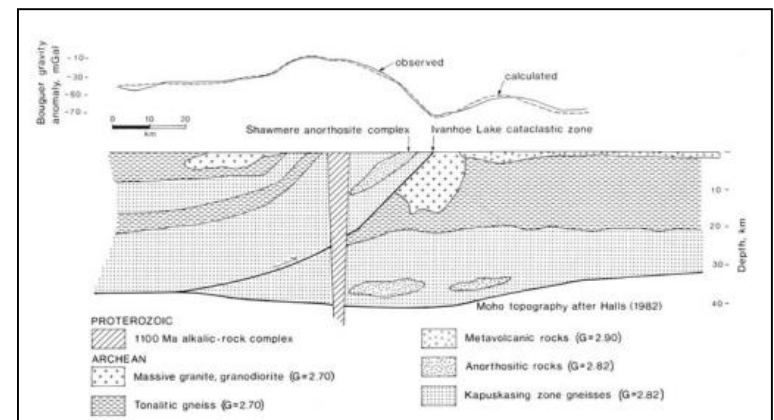
PART I: Geological Framework of the Kapuskasing Uplift

INTRODUCTION

The purpose of the trip is to examine the characteristics and interrelationships of Archean greenstone-granite and high-grade gneiss terranes of the Superior Province. A 300-km long west to east transect between Wawa and Timmins, Ontario will be used to illustrate regional-scale relationships.

Figures 1 and 2 show the major geological features of the central Superior Province; Figure 3 traces the trip route. On the first day we examine features of the Michipicoten belt, a dominantly metavolcanic

¹Geological Survey of Canada Contribution No. 25788



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94.4 km - Stop 1-4: Tonalite gneiss and mafic dykes (Fig. 20) (N. and S. of Hwy 101)



Figure 20. Large (25 m) Hearst dyke cutting tonalitic gneiss (Stop 1-4). Note easterly dip to western dyke margin.

Percival, J.A. (1990). A Field Guide to the Kapuskasing Uplift, a Cross Section through the Archean Superior Province. In: Salisbury, M.H., Fountain, D.M. (eds) Exposed Cross-Sections of the Continental Crust. NATO ASI Series, vol 317. (pp.227- 283). Springer, Dordrecht. https://doi.org/10.1007/978-94-009-0675-4_10

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The Kapuskasing uplift, located in central Canada, is a significant geological feature that has been the subject of extensive study. [Percival \(2019\)](#) and Wu (1992) both provide insights into its deep crustal structure, with Percival highlighting the presence of tonalitic and mafic gneisses and Wu suggesting that the uplift is a product of intraplate collision during the early Proterozoic. [Kurtz \(1993\)](#) further explores the conductivity of the crust and mantle beneath the uplift, proposing models that could explain the observed data. [Lafontaine \(2022\)](#) contributes to our understanding of the uplift's history by studying the geochemistry and geochronology of a gold-bearing gneiss in the region. These studies collectively enhance our knowledge of the Kapuskasing uplift and its geological significance.

The Kapuskasing uplift: a deep crust natural laboratory

J. Percival

Acta Geologica Sinica - English Edition

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Amazonia Through Time: Andean Uplift, Climate Change, Landscape Evolution, and Biodiversity

C. Hoorn · F. Wesselingh · +15 authors · A. Antonelli · Environmental Science, Biology · [Science](#) · 12 November 2010

TLDR It is shown that Andean **uplift** was crucial for the evolution of Amazonian landscapes and ecosystems, and that current biodiversity patterns are rooted deep in the pre-Quaternary.[Expand](#)

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A. Favre · M. Päckert · +4 authors · A. N. Muellner-Riehl · Environmental Science, Biology · [Biological Reviews of The Cambridge Philosophical...](#) · 1 February 2015

TLDR It is suggested that the biological consequences of the **uplift** of the QTP would be best understood using a meta-analysis approach, encompassing studies on a variety of organisms from diverse habitats (forests, meadows, rivers), and thermal belts (montane, subalpine, alpine, nival).[Expand](#)

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Yaowu Xing · R. Ree · Biology, Environmental Science · [Proceedings of the National Academy of Sciences...](#) · 3 April 2017

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NATURE AND COMPOSITION OF THE CONTINENTAL-CRUST - A LOWER CRUSTAL PERSPECTIVE

RUDNICK, RL and FOUNTAIN, DM

Aug 1995 | REVIEWS OF GEOPHYSICS33 (3) , pp.267-309

Geophysical, petrological, and geochemical data provide important clues about the composition of the deep continental crust. On the basis of seismic refraction data, we divide the crust into type sections associated with different tectonic provinces. Each shows a three-layer crust consisting of upper, middle, and lower crust, in which P wave velocities increase progressively with depth. There i... Show more

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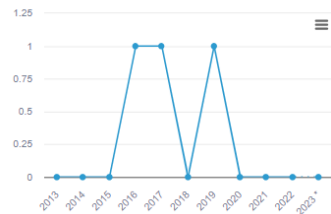
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Seismic reflection profiles across the central Kapuskasing uplift

AL Alain D. Leclair JP John A. Percival AG Alan G. Green JW Jianjun Wu GW Gordon F. West WW Weizhong Wang

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30 June 1994

Journal Article | Published by Canadian Science Publishing in Canadian Journal of Earth Sciences

Vol. 31 (7), 1016-1026 <https://doi.org/10.1139/e94-092>

Abstract

The central Superior Province is transected by the intracratonic Kapuskasing uplift, which contains rocks exhumed from 30 to 35 km paleodepth. As part of the Lithoprobe Kapuskasing transect, approximately 52 km of 16 s seismic reflection data were collected in the central segment of the uplift along three profiles that traverse the northern Groundhog River block, the bounding Saganash Lake fault, and the eastern Val Rita block. The seismic sections have the following characteristics in common: (i) a complexly reflective uppermost portion (< 1 s) limiting correlation of reflective zones and surface features; (ii) numerous subhorizontal, east- and west-dipping reflection zones; and (iii) a significant reduction in reflectivity beyond the refraction-defined Moho (~ 14 s). Beneath the Groundhog River block a series of straight, west-dipping (~ 20°) reflection zones between 2 and 10 s is underlain by subhorizontal reflections in the lower crust. Across the Saganash Lake fault, the Val Rita block is characterized by a maze of discontinuous, curvilinear reflections with general easterly dip down to 8 – 10 s, below which west-dipping events are prominent. A north-south cross profile reveals a highly reflective crust with dominantly horizontal reflection geometry below the Saganash Lake metavolcanic belt, and a steep truncation of reflection zones down to at least 7 s, which correlates with the surface trace of the Nansen Creek fault. This fault resembles well-known strike-slip faults in intraplate settings. The Saganash Lake fault, variably interpreted as a west-side-down normal fault with up to 15 km of throw or a major strike-slip zone, may be visible as a west-dipping, weakly reflective zone steeply truncating east-dipping reflections and becoming listric at depth. This interpretation accords with surface geological observations and gravity models for the structural geometry of the region in which the Groundhog River block is a thin thrust sheet of granulite perched on Abitibi belt rocks and truncated on the west by the crustal-scale Saganash Lake fault. Alternatively, the fault could be a seismically unresolved major transcurrent structure juxtaposing blocks with disparate reflection patterns in the upper 8 s. Limited amounts of late strike-slip motion have been inferred from various geophysical studies.

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LECLAIR, AD; ERNST, RE and HATTORI, K

May 1993 | GEOLOGY 21 (5) , pp.399-402

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This article presents a history of the development of U–Pb geochronology with emphasis on the role of Canadian researchers and some of its applications to Canadian geology. Modern U–Pb dating is the result of work by many individuals over the past 60 years, but the most important was Tom Krogh, who established methods that allowed determination of precise ages (<0.1% errors) on zircon using isotope dilution thermal ionization mass spectrometry. This was followed by the introduction of new analytical approaches by others, notably secondary ion mass spectrometry and laser ablation inductively coupled plasma mass spectrometry that allow intracrystal domains to be dated. U–Pb geochronology is now an indispensable tool for understanding the Earth. In collaboration with field mapping, it has vastly improved our understanding of the geological history of Canada as well as important geological events such as mass extinctions, secular changes in geological processes, and the birth of the solar system.

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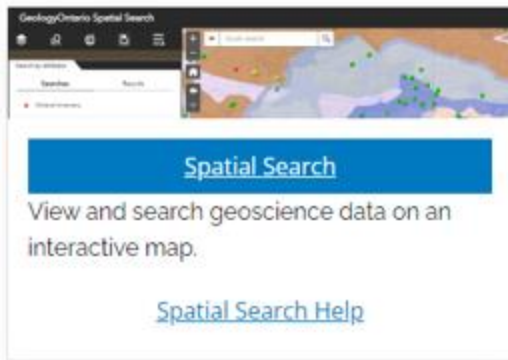
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9. Project NE-17-007. Tectonometamorphic History of the Wawa-Abitibi Terrane: A Deep Crustal Transect Through the Kapuskasing Uplift

J. Kendrick¹, C. Yakymchuk¹ and M. Duguet²

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²Earth Resources and Geoscience Mapping Section, Ontario Geological Survey, Sudbury, Ontario P3E 1

INTRODUCTION

The Kapuskasing uplift in northern Ontario is a natural laboratory for exploring Archean crustal processes. This project will investigate the metamorphic rocks exposed in the area to better constrain the tectonometamorphic history of this region using phase equilibrium modelling and garnet geochronology. This information will be used to understand the timing of high-pressure granulite-facies metamorphism and to determine its relationship to the overlying units. This report presents the project objectives and preliminary results of field work conducted as part of a PhD thesis project by the first author.

PURPOSE

Remnants of continental crust formed during the Archean Eon (4.0 to 2.5 billion years ago) preserved around the world, and decades of research have shown that the crust of early Earth differed significantly from modern crust (Taylor and McLennan 1985, 1995; Rudnick 1995; Rollinson 2002). One of the most significant unknowns about the evolution of our planet, and a subject of ongoing research in the international scientific community, is whether the modern process of plate tectonics was operating during the Archean (Condie and Kröner 2008; van Hunen and Moyen 2012; Turner et al. 2014; 2018). Plate tectonics may have operated differently or not existed during this time period, giving rise to continental crust with a distinct chemistry and architecture (Bédard 2006; Bédard, Harris and Turner 2013). However, Earth's early crust remains relatively poorly understood. Most Archean rocks that are exposed today represent the upper crust and the insights that can be gained from these rocks are limited. Exposed deep crust records essential information for understanding the formation and growth of continents (Percival, Fountain and Salisbury 1992; Jamieson et al. 2011). In addition, gold deposits hosted in Archean upper crust are an important source of gold in Ontario and Canada; accessing these deposits can provide important insights into mechanisms of gold mineralization.

GEOLOGY OF THE KAPUSKASING UPLIFT

The Abitibi and Wawa subprovinces of the Archean Superior Province are separated by the Kapuskasing uplift, an interpreted tilted crustal section exhumed during the Trans-Hudson Orogeny during the late Neoproterozoic and early Paleoproterozoic (Percival et al. 2012). The Kapuskasing uplift exposes a rare, nearly complete cross section of Archean crust, with the upper crust represented by the

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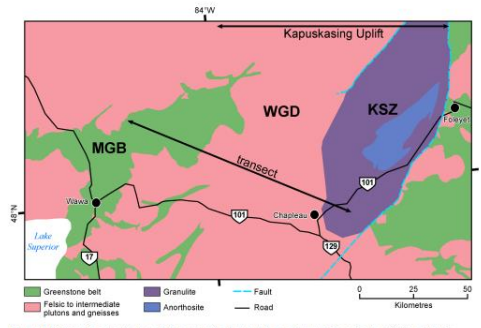


Figure 9.1. Schematic geological map of the Kapuskasing Structural Zone and surrounding region (modified from Ontario Geological Survey 2011) depicting the Kapuskasing uplift area. Abbreviations: KSZ, Kapuskasing Structural Zone; MGB, Michipicoten greenstone belt; WGD, Wawa gneiss domain.

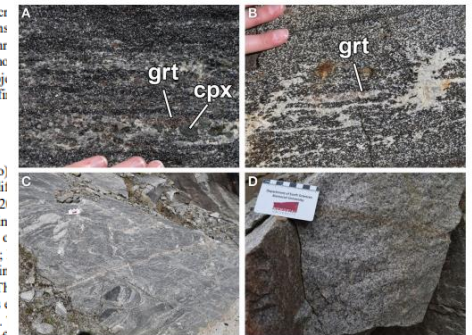


Figure 9.1. Outcrop photos from the Kapuskasing Structural Zone and the Wawa gneiss domain. A) A garnet and clinopyroxene-bearing granulite-facies metabasite in the Kapuskasing Structural Zone (UTM 342704E 5311082N, Highway 101 between Chapleau and Foley). B) Leucosome with peritectic garnet in an outcrop of mafic granulite, Kapuskasing Structural Zone (UTM 342706E 5311091N, Highway 101 between Chapleau and Foley). C) An outcrop of strongly deformed tonalitic gneisses, Wawa gneiss domain (UTM 279815E 5306043N, Highway 101 between Wawa and Chapleau). D) Massive tonalite, Wawa gneiss domain (UTM 666779E 5312558N, Highway 101 between Wawa and Chapleau). Abbreviations: cpx, clinopyroxene; grt, garnet.

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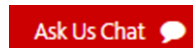
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